STATES DEPARTMENT OF AGRICULTURE
SERVATION SERVICE • WASHINGTON 25, D.C.

The FARM WOODLAND

SUBJECT MATERIAL for IN-SERVICE TRAINING

JULY 1947

by JOHN F. PRESTON • Former Chief of Forestry Division
SOIL CONSERVATION SERVICE

This paper gives ... ists should have about farm f... farm business. It indicates the ... farming picture, and enab... tively to farmers the advan... e. It outlines specific st... land operation as a part of ... tural methods to be used in man... ral principles of reforestation, ... hniques needed by farmers.

Necessarily, many gaps are left to be filled in locally, in accordance with local conditions. For example, in different parts of the country different tree species should be favored in farm woodland management as those of greatest value, different silvicultural practices give best results, and different tree species are best suited for use in reforestation.

TABLE OF CONTENTS

INTRODUCTION

A forest is a complex association of trees and other vegetation, animals, birds, insects, bacteria, and fungi. It serves man in many ways, directly and indirectly. It furnishes a great variety of necessary wood products. It conserves soil. It stores moisture above ground as snow and causes water from both rain and snow to percolate into the soil and become stored in underground reservoirs. It checks winds and thus moderates extremes of heat and cold. It has beauty of line, form, and color. It provides opportunity for hunting, trapping, and other recreation. It shelters birds that destroy harmful insects. Any farm woodland has all or most of these attributes of the forest, in a measure depending largely upon its extent and the care it receives.

A farm woodland supplies wood materials essential to farm operation. By checking winds it protects field crops, livestock, and the farmstead. It yields money income consistent with the investment in land and the labor cost of growing a wood crop. It gives opportunity for productive labor during off seasons. Its many beauties enrich farm life. Also, a profitable woodland can be developed on land too steep, too rough, or too infertile to produce well if used for field crops or pasture. If the woodland is not well managed with a view to producing wood crops and other benefits, however, it may become a sorry, nonproductive area, a drag on the farm economy.

Good farm woodland management means protecting the woodland from fire and grazing and developing or maintaining the largest and most productive growing stock of trees that site conditions permit, so that the farmer may reap all or some of the benefits just listed.

CHAPTER I. NATIONAL ASPECTS OF FARM WOODLANDS IN THE UNITED STATES

Farmers own about 139 million acres, or nearly 30 percent, of the commercial forest land of the United States. By "commercial forest land" we mean land capable of producing timber of commercial quality and quantity and available for that use. Of this total farm woodland area 60 percent is in the South, 38 percent is in the Northeast, the Lake States, and the Central States, and 2 percent is in the West.

Nearly one-third of the United States' present annual output of forest products comes from farm woodlands. However, the farms of the Nation could and should produce three times as great a volume of wood materials as they do now. At the same time, they could produce wood materials of better quality. Two-thirds of the volume of products now cut from farm woodlands is low-grade material such as fuel wood, fence posts, ties, and pulpwood. Good management could reverse the proportions of low- and high-grade products; two-thirds of the output could be such products as sawlogs, veneer logs, poles, and piling.

Through woodland management, in periods of normal prices, farmers of the United States could increase their total annual income by 500 million dollars. This gain to farmers would be accompanied by a saving to users of forest products; farm woodland products, largely because of the accessibility of the woodlands, are cheap to the consumer.

Adequate Wood Supplies for the Nation

Forests furnish materials indispensable to our national welfare — lumber for construction, poles for communication, ties for transportation, pulpwood for paper, boxes for marketing, and wood for countless other common uses. The demand for wood for new uses is upon us. Such developments as impreg, compreg, staypak, papreg, laminated and moulded wood, and wood plastics are bound to increase the demand for wood products. We have learned that an unfailing supply of wood products for the Nation is just as essential in peace as in war.

Farm woodland is called upon now to furnish about one-third of all the wood products harvested from American forests. This is more than one-third of all wood products now consumed by the Nation. The demand upon farm woodland is increasing. In order to meet the demand, it is essential that we increase production. Production can be increased only by better protection and management; if we are to have adequate wood supplies for our Nation, it is imperative that we have better farm woodland protection and management. This will raise both the quantity and quality of the wood products grown on the farm.

Increasing Demand for Wood for Industry

To some extent wood products are interchangeable with products grown under clean tillage. For example, rayon made from wood can be exchanged for fabric made from cotton, and plastics can be made from wood fiber as well as from various crops grown on cultivated land. The importance of farm woodlands increases as industries call for more and more raw material produced from either cultivated or forest land. During 6,000 years of agriculture the hardest problem facing the tiller of the soil has been how to establish an enduring agriculture on sloping land, and no one has ever yet learned to grow tilled crops on steep slopes without using intensive conservation practices or ruining the land. Almost all the world's land suitable for cultivation is now being used to produce food, feed, and fiber. Most of it is sloping land. Cultivation to grow raw materials for industrial use can be extended only by pushing it still farther up the slopes, with increasing hazards to the soil. The greater the volume of these raw materials that can be derived from the forest, the less the danger of destroying the productivity of millions of acres of steeply sloping farm land by cultivating it.

Woodland Influence on Runoff and Soil Erosion

Conservation of farm soil is a necessary means to permanent agriculture in the United States. We know now that farm land is not an indestructible resource. Farm woods in good condition, including farmstead windbreaks and field windbreaks, are among the strongest defenses against soil erosion. Water that falls on protected, ungrazed woodland, even on a steep slope, and is not at once utilized by plants percolates into the soil without serious runoff and without damage to the soil. This is due chiefly to the fact that woodland soil is normally overlain by a mat of dead and decaying foliage that is highly absorptive and that protects the soil and keeps it permeable.

Figure 1--Farmers own about 139 million acres, or nearly 30 percent, of the commercial forest land in the United States.

Figure 2--Southern pine pole stand in need of thinning.

Besides preventing erosion, the woods helps stabilize the water table so that a regular supply of underground water is available for crops and to feed springs.

Either under natural conditions or under good management — that is, protection from fire and grazing, and good silvicultural practices — a farm woodland forms a part of nature's defense against floods. One spring does not make a river, and one farm woods has little effect in flood control, but millions of separate parcels of farm woodland together can have a tremendous effect by conserving soil and retaining water.

The national welfare requires that all forests function to control soil erosion and floods, and farm woodlands should not be an exception. This is a matter worthy of study in every soil conservation district where forests occupy any appreciable part of the farm land.

The Farmer's Opportunity

Management of a woodland is part of the farm business; and it is part of the farmer's responsibility to do the best possible job in producing wood products.

A farmer cannot avoid managing his woodland. He may do a poor job and get almost nothing in return, or he may do a good job and get a very satisfactory return.

If the 40 percent of private forest land owned by farmers is not so managed that it will produce ample quantities of forest products and will contribute to control of abnormal runoff and soil loss, the farm owners and everyone else will suffer. If the farm woodlands are protected and well managed, not only the farmers but the entire country will benefit.

CHAPTER II. VALUE OF WOODLAND TO THE FARMER

Material for Farm Use and for Farm Profit

On many farms, the woodland areas have been reduced to a low state of productivity by wasteful cutting and by fire and grazing. Long periods of good management will be necessary before any considerable quantities of high-grade forest products can be cut from them for farm use or for sale. However, very few farm woodlands cannot now produce some usable wood material, and under good management the woodland is a source of continuing production.

Almost 250 million dollars' worth of wood products annually are grown and used on the farms of the United States. The average farmer needs about 100 fence posts, 12 cords of firewood, and 1,000 board feet of lumber annually to operate his farm. These wood products should be obtained from the farm woodland. A farmer who has labor available for woods work and needs timber products to operate his farm acts very foolishly if he sells standing trees and buys the same kind of products he could have obtained from them.

From 5 to 10 percent of farm woodlands, in various parts of the country, have a stocking of merchantable trees adequate to support commercial cutting operations from now on if the cutting is done right. At present 100 million dollars' worth of wood products are sold from farm lands each year. Farm woodlands are capable of producing much greater quantities of material for sale.

Actual records on Norris-Doxey farm forestry projects are beginning to show the possibilities of revenue from farm woodland management. Most farmers still sell standing timber rather than processed forest products, and very few, even of those who are managing their woodlands intensively, have begun to cut each year or periodically as much wood as grows. Therefore, average incomes reported for farm forestry projects are only an indication of what farmers will receive when they begin to manage their woodlands as they do their fields. It appears that woodland income will gradually increase as woodland growing conditions improve, and especially as more farmers realize that greater income can be obtained by selling harvested forest products than by selling stumpage. Here are some Norris-Doxey records:

Fiscal year	Farms reported	Farm woodland under management	Products cut				Net value of products		
			Total		Per acre		Total	Per farm	Per acre
	Number	Acres	Feet B.M.	Cords	Feet B.M.	Cords			
1943	148	15,506	3,112,880	7,906	200	0.51	$ 38,371	$260	$2.47
1944	509	49,155	9,694,355	26,694	197	0.54	162,943	320	3.31
1945	441	44,126	19,910,281	60,059	451	1.12	213,941	485	4.85

Protection Against Loss of Soil and Water

A well-managed woods protects the individual farmer from loss of needed soil and water and from loss caused by deposits of eroded soil material. Particularly, it prevents washing of topsoil from lands of steep slope. If a woods on steep land at greater elevation than adjacent cleared land is removed, the usual result is not only loss of the timber-producing capacity of the woodland soil through erosion but also damage to the cleared land through gullying or through deposition of sediment and rocks. A woods on a gentle slope, by keeping the soil in an absorptive condition and keeping the passages to underground storage open, can cause large volumes of surface water flowing from open land above to percolate into the ground when it reaches the tree-covered area.

Studies of runoff from cultivated, pasture, and wooded lands in the Ohio River Valley by the experiment station of the Soil Conservation Service near Zanesville, Ohio, showed that annual water loss from an acre of forested land averaged only one-ninth as great as that from an acre of cultivated land. A 6-year study at the Guthrie, Okla. experiment station of the Service showed that the average yearly runoff from an area of old-growth woodland having a 5.17-percent slope was but 0.2 of 1 percent. From an area of 7.70-percent slope in continuous cotton, the runoff was 14.22 percent. The yearly soil loss from the old-growth woodland was 0.017 ton per acre as compared with 24.29 tons per acre from the land in continuous cotton.

By reducing wind velocity tree windbreaks reduce soil blowing in regions, such as the Great Plains, where dust storms are a serious hazard of agriculture. The capacity of wind to pick up and move soil particles varies at least as the square of its velocity; a 20-mile-an-hour wind has 4 times as great a capacity to pick up soil as a 10-mile-an-hour wind. Even a 10-percent reduction in wind velocity may mean the difference between much soil blowing and very little.

Where wind creates erosion hazards, trees planted in rows at right angles to prevailing winds give some protection to the leeward for distances up to 20 times the height of the trees. For example, a belt of trees 50 feet high may give leeward protection to a horizontal distance of 1,000 feet. It gives protection on the windward side, also, sometimes to a distance 5 times the height of the trees.

Temperature and Other Influences

Woodlands temper both hot and cold winds. Thus they have a favorable influence on air and soil temperatures and protect crops, livestock, and farmsteads. On many areas in the Great Plains, efforts to grow garden produce and fruit have succeeded only where the vegetable and fruit plantings were protected by windbreaks. Particularly in the Plains, woodlands protecting farm buildings from winter winds add much comfort to farm life and have increased farm sale values. Windbreaks that reduce winter wind velocities by 50 percent may reduce by as much as 30 percent the amount of fuel required to maintain an indoor temperature of 70° F., according to findings of the Lake States Forest Experiment Station. By influencing air currents, tree and brush cover may eliminate frost pockets.

Other influences of farm windbreaks and woodlands that favor crop plants include reducing evaporation of soil moisture, increasing the relative humidity of the air, and — in northern regions — causing accumulations of moisture by holding snow on the fields. These influences vary with season, crop, and local climate and, especially, with the width, length, density, and height of windbreaks and the distance between them.

Wildlife Values

Farmers recognize the value of birds that live in woodlands and make foraging trips to their fields, waging continuous warfare on harmful insects and rodents. These birds — woodpeckers, sapsuckers, wrens, thrushes, hawks, owls, and a host of others — assist farmers by holding in check the destroyers of growing crops.

Woodlands are the natural habitats of small-game animals and of valuable fur bearers such as the skunk, martin, racoon, and fox. Fish and important fur-bearing mammals inhabit flowing streams and other waters within woodland areas. Of economic importance also are the big-game animals that inhabit the larger woodlands. Aside from obtaining meat, hides, and fish by hunting and fishing, the woodland owner sometimes can collect hunting fees from sportsmen.

Intangible Values

Some woodland values are based on such things as sentiment and love of beauty. There are woodland owners who seem almost to reverence their trees. To them trees have a very high sentimental value both individually and as farm woods. They want to keep their farm woodlands intact, or to remove only dead and down material. Sentimental appreciation has an important part in preserving woodlands and permitting them to continue to control runoff and erosion and give protection from extremes of heat and cold. However, woods appreciation based solely on sentiment may result disastrously for a farm woodland if the farm changes hands and the new owner does not have the same high regard for woodland. The fact that the woods has brought in no actual cash and the trees have grown to large sizes, indicating high market values, is likely to bring a sudden and complete reversal of policy, resulting in clear cutting of the salable trees. Therefore, appreciation based on commercial as well as sentimental factors gives the woodland a much more secure place in the farm economy.

An appreciation of woodland values that leads the farmer to refrain from excessive cutting of forest products and maintain a good woodland growing stock brings other intangible benefits. Among these are opportunity for recreation, including hunting, and the beauty of blooming dogwoods, redbud, Juneberries, and other trees and shrubs. These things have real significance in the lives of many farmers.

CHAPTER III. SOME MAJOR FACTORS IN FARM WOODLAND MANAGEMENT

The Woodland as a Farm Enterprise

The woodland capital is the soil plus the tree growing stock, and interest on this capital becomes available to the woodland owner in the form of tree growth. The profitable way to handle a woodland is to remove each year or in each period of several years a quantity of material not greater than that produced by growth within the same length of time. The growing of wood crops usually does not require lime, fertilizers, or cultivation, and trees can be grown with less labor than most other farm crops. Nevertheless, woodland management is not profitable as a haphazard affair. There must be a definite decision to manage the woodland as a farm enterprise, and a definite plan of management. If the owner postpones this decision, with a vague idea that maybe sometime he will clear the woodland area and convert it to another use, the woodland will produce very much less than it could.

Usually, no difficult techniques of forestry or logging are needed in managing a farm woodland. Growing trees is not an involved or difficult undertaking. Felling trees and converting them into logs, pulpwood, fuel wood, and other products actually are among the more simple operations of farm management. None of the equipment required is difficult to operate. The necessary equipment and either animal or mechanical power for hauling the products are available on most farms. The details of how a farm woodland shall be managed and the means by which it shall be managed can easily be worked out.

Farm forestry is not a forestry job on farm land; it is a farm job on forest land. There is a great difference between these two concepts and the corresponding ways of approaching the project.

If, after considering all factors, the farmer decides that he wants to grow timber as a farm crop, the job of developing the farm woodland takes its place on a par with other farm enterprises. The farmer then needs technical assistance. In the first place, he needs help in planning. The farm must be analyzed to find out just what place in the farm economy the woodland can fill, and a plan must be made for woodland management. Next the farmer wants to know what woodland-management practices are best and how to apply them. He is likely, sometime, to need specialized technical help in marketing his woodland products.

Woodland Assistance to Farmers

Farmers need woodland assistance at three levels:

Level 1. Education in farm woodland values, and planning. First come the steps needed to get the farmer to see the advantages he can gain by practicing farm forestry and to undertake a farm woodland enterprise. The level 1 job in farm forestry is a farm job, because it cannot successfully be separated from other farm advisory activities. It can be done at least as well by agricultural workers not intensively trained in forestry as by forestry specialists, because the two determining factors are land capabilities and farm economics.

Level 2. Instruction in forestry techniques. Some farmers are able to work out the techniques they need to apply in their woodlands through their own ingenuity, with the help of some of the many farm forestry bulletins that are available to them. In the early stages of management of the average farm woodland, application of forestry techniques is a simple matter—systematic improvement cutting. However, the farmer can make much better progress if he is assisted by a forestry technician or farm conservationist in beginning and continuing the practices required. The level 2 job includes demonstrating how to select trees for cutting — by marking sample areas — and showing farmers how to utilize trees to obtain the most useful or valuable products. It also includes assistance in measuring products and in locating markets for those that are available for selling, advice or values of products, and sometimes advice on planning the logging operation.

Level 3. Specialized technical help in making money from sale of products. This includes expert cutting and marketing assistance. Profit in forestry depends largely upon the character of marketing techniques and the scale on which they are applied. At some stage in the development of a forestry program, the farmer who has a considerable woodland acreage can make a great deal more money if he not only manages his woodland intensively but sells the products skillfully. The assistance he needs in order to do these things is outside the duties of most of the agricultural public agencies. At this level, the farmer should help himself. Since application of technical skill at this level results in greater income, obviously the farmer should avail himself, so far as possible, of the services of a consulting specialist or other

technician on a fee basis to perfect his woodland program. Level 3 instruction includes how to make most money from forest products. In some States, service at level 3 is offered to farmers by the State forester, free or at a nominal charge.

No absolute line can be drawn between assistance levels 2 and 3. The difference is often that between technical guidance in woods work and supervision of a logging operation, or that between giving reliable advice on marketing forest products and making actual arrangements for selling, grading, and measuring the products. Farmers following the principles of integrated farm forestry (explained later) rarely need level 3 assistance. Among those who do need it are the farmer who decides to manage his woods on commercial forestry principles; the woodland owner who, because of absence or for some other reason, cannot supervise cutting operations or the execution of a cutting contract; and any farmer who, having a considerable area or volume of timber of high or potentially high quality, must call in a technician to select the trees ready for harvest now, indicate which ones will bring more money after further growth or if sold in a different market, and direct the cutting.

Woodland Protection

The soil of a virgin forest or a well-managed woodland is stable, not subject to erosion; it retains moisture; it has a complete stock of plant nutrients and is capable of renewing them continuously. This soil is covered with litter, the debris of dead vegetation. Decay of the litter transforms it into humus, and intermingling of humus with the underlying mineral soil deepens the layer of fertile forest soil. Forest soil is alive with fungi, bacteria, and minute animals. It has a large population of earthworms and burrowing animals. It is the source of nourishment for trees and shrubs and, indirectly, for the wild creatures. On all woodland sites, the rate of growth of the trees and the quality of the material produced depend upon how nearly the natural conditions of the forest soil are maintained.

Fire may seriously damage or even destroy this source of life. Of course, it may also completely destroy the plants, both trees and shrubs. The grazing of animals, through trampling of the soil and destruction of plants, also may greatly reduce the forest soil's capacity to produce valuable tree growth. By removing the protective understory of shrubs and young trees, it gives full sweep to drying winds that absorb soil moisture otherwise available for tree growth. A forest soil that is damaged by burning or grazing can no more produce abundantly than can a pasture or cultivated soil gullied by runoff and worn out through constant drain of fertility and organic matter.

Obviously, damage by fire and grazing must be stopped before a woodland enterprise is a safe venture. It is no use to undertake a forestry program calculated to increase volume growth and improve quality, if fire is robbing the soil of its fertility or if grazing animals are trampling the soil and destroying the young tree growth. Without protection from fire and overgrazing, there is no future for the farm woodland.

In some cases the cost of preventing damage by fire and grazing may be so great in proportion to the prospective benefits from woodland management that the farmer will justifiably decide not to undertake a farm woodland enterprise, but to clear his wooded area and devote the land to some other use. Or the value of the woodland to the farm as winter shelter for livestock may be greater than the timber values that could be obtained through management. In such a case, unless some compromise of conflicting interests permits using part of the woodland area solely for timber production, the only logical decision is to abandon the idea of a woodland enterprise.

Integrated Farm Forestry

Integrated farm forestry may be defined as managing farm woodland areas so that they make their largest possible contribution to the purposes of farm management. These purposes, on a great majority of farms, are the largest permanent farm income and the best current living for the farm family. Integrated farm forestry contributes to farm income and farm living by producing materials such as fuel, posts, poles, timbers, and lumber for use on the farm or for sale and by furnishing opportunity for productive use of labor and equipment at times of year when they are not in demand for other farm enterprises.

For most farms, integrated farm forestry means acceptance by farmers of these rules for managing the farm woodland:

1. Treat the woodland as part of the farm business and grow forest tree products as farm crops. Develop and maintain a growing stock of trees by protection, improvement cutting, harvest cutting, and, if necessary, planting.

2. Sell only processed products, not stumpage; sell on scale or measurement, not for a lump sum.

3. Regulate cut. Determine the quantity or volume to be cut annually or periodically on the basis of the productive capacity of the woodland.

Rule 1 means using good silvicultural methods, the first step in developing a woodland enterprise. This alone may not result in the type of forestry best suited to a family-sized farm. For example, a farm owner could practice good silviculture and nevertheless let a period of 10 or even 20 years elapse between cuttings. This interval might be entirely satisfactory to an absentee owner, but it would not be the best management for the ordinary farm. A large farmer may not want to bother with frequent woodland cutting and may prefer a 20-year cutting interval. Usually, absentee owners and large farmers prefer stumpage sales. On the other hand they may practice good silviculture and be very careful in carrying out selection cutting or clear cutting, whichever is the recommended practice. Such farmers usually prefer to have their timber cruised, because that is necessary for greatest profit from large sales of stumpage. Farm planners are expected to encourage such farmers to follow good forestry practices, but frequently the technical help required is of level 3 and hence should be obtained from consulting foresters who charge for it.

Rule 2, eliminating stumpage sales, means greater money returns to the farmer who sells woodland products. An absentee owner is sometimes interested in selling processed products if he has a local foreman, or can employ a timber agent, to supervise the processing. On an average, in selling processed products there is a business profit of 27 percent on pine logs, 31 percent on hardwood logs, 6 percent on pulpwood, and 20 percent on fuel wood. For example, hardwood stumpage valued at $5.00 will produce logs worth $20.00 at the mill. If the farmer sells stumpage, he gets the $5.00 and nothing more. If he puts his own labor and the use of farm horses into cutting and skidding the logs and delivering them at the mill, he receives not only the $5.00 but $8.80 for the labor plus $6.20 as profit. The farmer can keep most of the $6.20 even if he hires all his labor and contracts for the hauling of the logs. Sometimes it pays the farmer to operate a sawmill and sell lumber rather than logs.

Rule 3, adjusting the scale of cutting to the productive capacity of the woods, calls for approximation only. The forestry specialist cannot tell exactly what volume of wood products should be cut for any given period in order to have sustained production. He can only estimate it, by studying the growth of the trees and modifying his calculations of current growth according to the condition of the growing stock. In the beginning stages of farm woodland management a study of growth is not needed. Simple rules based on experience gained through "cut and try" methods are usually sufficient.

Time for Woods Work

There is truth in the common saying "The farmer's work is never done." A farm is a busy place, where jobs to be done are never lacking. Most farm jobs have a time urgency; there is a time for planting, a time for cultivating, and a time for harvesting, and the farmer cannot ignore any of these. Unless field crops are harvested when they ripen and are promptly put into condition for sale, for use, or for storage, heavy losses occur. With a wood crop there is much less time urgency, and most of the work necessary in growing and harvesting can conveniently be fitted into the farm labor schedule. This is a point of strength and also of weakness. The fact that woods work can be done at times when it will not interfere with other jobs makes it easier for the farmer to decide on a woodland-management project and easier for him to carry one out. On the other hand, if a farmer who owns a woodland is only half convinced of the value of a woodland enterprise, woods work is likely to come so low in his scale of priorities that it will never be done.

Too often the farmer gives woods work only so much time as is absolutely required to harvest needed fuel and posts. Often advance planning and a little labor added to what is required to get out these products will enable the farmer to produce sawlogs — and he can get the fuel and posts from the tops of the sawlog trees. In other words, if woods work is carefully planned it produces far greater values in proportion to the labor expended than it would if done without plan merely to get urgently needed wood supplies.

Labor Required for Operating a Farm Woodland

Of course, woods labor does not necessarily mean on-the-farm labor. The farmer may hire labor for timber cutting just as he hires it for other harvests. Such figures as are available indicate that a higher average rate of income for labor is obtained in woods work than in many other farm activities. For example, in the Norris-Doxey farm forestry demonstration projects, during the fiscal year 1944, reports on 509 farms in 19 States showed hourly wages earned by farmers for woods work ranging from 56 cents to $2.44. A study of 89 farms in the oak-hickory zones of the Central and Lake States Regions showed farm woods labor incomes for the 6 years 1940-45 ranging from 26 cents to $1.33 per man-hour. A similar study in Ohio, Indiana, and Michigan in 1945 showed hourly returns for labor on sugar maple woods, after deduction of all expenses including taxes and interest on land and equipment, ranging from 89 cents to $2.47.

Information as to how many man-days are required for growing and harvesting a wood crop in a farm woods is useful in planning a woodland program. Figures from the Virginia Norris-Doxey farm forestry project show an average of 2/3 man-day per acre each year. According to Forest Service estimates a fully developed northern hardwood farm woodland in New York produces, on an average, 340 board feet of logs and 0.85 cord of fuel per acre each year. Cutting these products and skidding them with either horses or tractor requires about 0.8 man-day.

The usual labor requirement for operating a high-quality 200-acre woodland in southern Arkansas was estimated by the Southern Forest Experiment Station as follows:

	Man-days per year
Cutting and skidding	137
Building fire lanes	3
Marking timber	2
Supervision, scaling, etc.	3
Total	145
Average per acre	0.72

CHAPTER IV. FARM PLANNING INVOLVING THE WOODLAND

Preliminaries

Wherever a woodland enterprise is a possibility, the farm planner should find out whether the farmer is interested, or seems likely to become interested, in undertaking such an enterprise. A visit should be made to the woods with the farmer to determine, for example, whether it has been cut over recently, whether it is of a good timber type, and whether it is within the pasture enclosure. Some planners use a check sheet to record such information. Even if a woodland has been severely grazed and burned and has little or no tree reproduction, the farmer should be encouraged to

put it under management for wood crops if such management seems likely to prove more satisfactory than any other in the long run. In all cases, the planner should emphasize the importance of protecting a woodland from fire and grazing. If the farmer does not agree to undertake a woodland enterprise, the planner should try to get him at least to install minimum protection measures where these are necessary to prevent serious damage to soil or trees.

Fitting Land Use to Land Capability

For classifying the capabilities of land areas the Soil Conservation Service uses a simple scale based on soil, slope, and erosion. Lands are divided into eight classes according to suitability for cultivation and requirement of soil-conserving practices as follows:

Suitable for regular cultivation:

I. No special practices

II. Simple practices

III. Intensive practices

Suitable for occasional or limited cultivation:

IV. Limited use and intensive practices.

Not suitable for cultivation but suitable for permanent vegetation:

V. No special restrictions or special practices

VI. Moderate restrictions on use

VII. Severe restrictions on use

Not suitable for cultivation, grazing, or forestry:

VIII. (Ordinarily this is extremely rough, sandy, wet, or arid land. It may have value for wildlife.)

Wherever woods exist on lands of suitable capability classes, planners should advise farmers to manage the woodlands for production of wood or other forest products as a farm crop unless it is clearly evident that converting the land to other uses is a necessity of farm economy. Before any such farm woodland is cleared the probable benefits from growing wood products as a farm crop should be balanced against cost of clearing, cost of conservation practices after clearing, and prospective returns from other use. Wooded land of classes III and IV should be cleared only where additional acreage for hay or pasture is necessary to make a balanced farm unit. Land of classes V and VI now wooded should never be cleared for cultivation. It may be converted to pasture or to perennial hay if the forage needs of the farm require this. Land of class VII now wooded should never be cleared for any purpose.

In general, if existing timber occupies land of class I or class II, it may be well to remove the timber and use the land for cultivated crops or for pasture. The farmer should carefully consider the matter from the standpoint of what use his land is best suited for and what use can be expected to bring the greatest or most satisfactory return. If, after carefully considering all factors, the farmer concludes that he wants to retain the timber and manage it, even though it occupies class I or II land, the result is likely to be a stable woodland enterprise. Where immature timber is present on land of class I or II, instead of clearing the land immediately it is sometimes advisable to practice timber management until the wood crop reaches usable or marketable size.

Regardless of land capability class, if the expense of conversion from timber to other uses is high the question arises whether other land on the farm can be converted at less expense. Improving existing pastures to increase forage production is usually less expensive than converting woodland to pasture. Another alternative is purchasing or renting lands for pasture or cultivation. The planner should discuss the alternative courses with the farmer in such a way as to help him make a wise decision.

Very often a farm contains open land of class IV, V, VI, or VII that should be reforested. Old fields may be planted with trees to increase the area of woodland so as to provide a greater volume of wood products in the future and enlarge present opportunity for productive use of winter farm labor. The chief immediate purpose of planting may be to complete a protective ground cover, to provide food and cover for wildlife, to stabilize sand dunes, or to improve the appearance of the farm and thus favorably influence its sale value. Rarely will any farmer select land of class I, II, or III for reforestation. Exceptions are small areas planted with trees for quick production of posts or Christmas trees or, in the Great Plains, for windbreaks.

Economic Factors

Items of farm economics that may need to be discussed with the farmer before he decides whether to undertake a farm woodland enterprise and that certainly must be discussed with him if he does so decide are these:

a. Farm need for woodland products

b. Farm need for revenue that might come from sale of surplus woodland products

c. Permanent farm labor available for woods operations without additional cost.

d. Temporary labor available for hire or on a work-exchange basis

e. Cost of protective measures necessary

f. Purchase or rent of equipment for handling forest products

g. Construction of woods roads

h. Volumes of wood products that could be handled efficiently with labor and equipment in sight.

i. Improving woodland growing stock

Revenue from the woods.—Most farmers are highly susceptible to talk about possible additional revenue. A farmer operating a large cattle ranch or other large farm, or a corporation-owned farm used for producing lettuce, potatoes, fruit, or some other specialty crop, may not be interested in possible revenue from a woodland. However, he may be interested in the value of the protection timber can give his other crops.

Available labor.—From the standpoint of integrated farm forestry it is most important to find out how much labor can be used, without detriment to other enterprises, in woodland development work or in handling woodland products. Making full use of seasonal labor by managing a farm woodland is one way to help the farm income.

In most woods operations two men can work more efficiently than one. Fuel, posts, and pulpwood can be cut efficiently by 1-man crews; sawlogs, railroad ties, and similar products are better handled by 2-man crews. Therefore, the availability of hired help and the cooperative relations among farmers have an important bearing on farm woodland projects.

Equipment.—Even under the crudest conditions, woods work requires a team or a tractor; some stout harness; such tools as clevises, log chains, saws, axes, and cant hooks; and, sometimes, special equipment such as power-driven chain saws or drag saws, winches, steel cables, and log wagons or trucks. Information on equipment needed can be found in Department of Agriculture Farmers' Bulletin 1907, entitled "Equipment and Methods for Harvesting Farm Woodland Products," which may be had free on request. The farm planner should discuss with the farmer the subjects of proper woods equipment and how to get it. For farmers who do not have heavy draft animals, animals already trained to woods work, or tractors well suited for this work, possible solutions are collective purchase of needed equipment and rental of equipment through soil conservation districts or cooperative associations.

Woodland accessibility.—Timber cannot economically be ground skidded more than a few hundred feet. If a permanent road system serving the farm woodland cannot be built or maintained, this factor may determine what kind of woodland program is possible or may postpone any activity under such a program indefinitely.

In a large woodland an immediate sale of timber representing a heavy cut may be necessary in order to pay for woodland roads. Such a sale should be limited to the least volume required to justify building permanent improvements. After the cutting a new plan of operations is needed, providing for regular (preferably, annual) harvests of wood products integrated with the farm business.

Protective measures.—If livestock are damaging a woodland to an extent seriously affecting growth of the tree crop, it may be necessary to fence the woodland, or to fence the pastures. On the other hand, the animals may be kept out of the woods entirely or for long periods through livestock management, without fences, by improving existing pastures; the good forage provided by a well-developed open pasture is far more satisfactory to livestock than the starvation rations they can obtain by grazing woodlands.

To protect woodlands from fire, particularly along railroads, it is often necessary to construct firebreaks. Sometimes one firebreak along a railroad right-of-way will protect more than one farm woodland. An instance is a firebreak about 150 feet from a railroad track and about 500 feet long. It was a single fire lane about 2 feet wide, cut to mineral soil. The land between the fire lane and the railroad was burned over annually to form a wide protective strip. This firebreak was maintained at a cost of only about $2 a year, but it protected the woodlands of three farms from fires that had previously occurred each year.

Volume of cut and condition of growing stock.—When the farmer and the farm planner have inspected the farm woods, and know about what kinds and sizes of timber the woods contains, they begin to balance the labor and equipment available against the kinds of products that can be obtained from the woods. Here they need some rough converting factors. For example, perhaps it takes 3/4 man-day to make a cord of fuel wood, or 1-1/5 man-days to make a cord of peeled pulpwood, and 1 man-day—plus a day's use of a team—to fell, buck, and skid 1,000 board feet, log scale, of hardwood timber. The planner needs to convert the man-days of labor available into volume of wood products and then roughly determine whether it looks reasonable to start operations on that basis.

Program for the First Few Years

The program for the beginning period of not more than 5 years should be summarized and included in the plan of conservation operations. This program will include:

a. The protective measures, including fences and fire lanes.

b. Whatever thinning or other silvicultural development operations are contemplated, with a tentative time schedule.

c. Each year, improvement and harvest cutting; for example, cutting of 15 cords of fuel, 7,000 board feet of sawlogs, and 500 fence posts, requiring approximately 30 man-days of woodland work.

d. The reforestation program, if any. This will include tree species, methods of planting, and a schedule of planting by fields and years.

Now the farmer has a plan for immediate action in his woodland, together with an idea of his ultimate goal. No timber cruising has been suggested, no growth studies, and no complicated calculations dealing with regulation of cut. A little judgment has been used as to the volume of merchantable timber.

Place of the Forestry Specialist

The logical field of the forestry specialist in farm woodland planning, in addition to study and analysis of the woodland situation, is to train farm planners in applying approved woodland management techniques. Also, he will develop markets to facilitate the sale of any farm woodland products that are surplus to farm needs. Development of markets involves a good deal of work, in any community. It requires cooperation from the buyers and users of wood, and in some cases organization of farmers to provide better marketing facilities.

CHAPTER V. SOME FORESTRY FUNDAMENTALS

Site Quality

Farm woodland sites can be appraised as good, medium, or poor on the basis of the character of tree growth on them, the soil conditions, and the aspect. For hardwoods the best sites are those having deep, permeable, moisture-retentive soils, regardless of the surface conditions. Walnut, yellow poplar, basswood, hard maple, and white ash, if the trees are thrifty and of good form, are sure indicators of a good forest site. Red and white oaks associated with hickory and the better pines usually indicate a site of medium quality. Post and blackjack oak associated with hickory indicate a poor site. Scrub pine of any species in pure or nearly pure stands, in hardwood country, indicates sites that have degenerated because of grazing, fire, overcutting, erosion, or a combination of these destructive factors. Scrub pine is nature's mantle for damaged soil. In hardwood country it is a temporary type, necessary for restoring soil productivity and thus preparing sites for eventual return of a pure hardwood type.

Crown Classes

The tops or leafy upper structures of trees, known as their crowns, together form the forest canopy. The relative position of the crowns of individual trees is an important consideration in developing the growing stock. Foresters classify trees in a forest stand as dominant, codominant, intermediate, and suppressed. Dominant trees are those whose crowns are above the general level of the canopy and receive full light from above and from one or more sides. Codominant trees are those whose crowns reach the general level and receive full light only from above. Intermediates are trees whose tops are just below the level of the crowns of the codominant trees and receive some light from above. Suppressed trees do not extend into the general crown level and do not receive any direct light. Obviously, the dominant and codominant trees are in the best position to thrive, and if these are of good form and properly spaced they are the ones to be selected as crop trees—that is, healthy, well-formed, well-spaced trees that are to constitute the major forest crop. Of course, the dominant and codominant crown classes include wolf trees, trees that have grown in a former uncrowded stand to such size that they take up much more than their share of growing space. Generally, wolf trees are undesirable except as seed producers.

Figure 3--Farm woodland in Ohio after improvement cutting.
Figure 4--This farm woodland in Georgia supplies large quantities of poles and cordwood.

Intermediates are depended upon to take the place of the dominants as these are removed. Suppressed trees, when cutting frees their crowns, may develop into thrifty trees of good form. Trees of some species, if once suppressed, never can become useful. Suppressed trees should be cut if they contain useful products and are not needed to protect the soil.

Silvicultural Cuttings

Methods of cutting for stand improvement referred to here include improvement cuttings, weedings, release cuttings, and thinnings.

"Improvement cutting," according to the definition of the Society of American Foresters, is "a cutting made in a stand past the sapling stage for the purpose of improving its composition and character by removing trees of less desirable species, form, and condition in the main crown canopy." This kind of cutting is the first stage in management of the average depleted farm woodland. It requires selection of species to be favored. Wolf trees and diseased and insect-infested specimens are removed, and in general the stand is renovated. The main crown canopy must be kept unbroken, except where it is intentionally opened up in order to get reproduction. Improvement cutting is intended to produce materials that can be used or sold; accordingly, the trees cut are worked into products that are in demand. Often the cutting involves erosion hazards created by logging on sloping land. Sometimes this can be avoided or the damage limited by skidding logs more or less on the contour and by disposing of slash in such a way that it prevents undue washing of skid trails or roads. If improvement cutting is carried on systematically, both the volume and the quality of the products obtained from the forest gradually rise.

"Weeding" is removal, during the early stages of stand development, of trees, shrubs, and vines that would adversely affect the form and growth of more desirable trees. It is rarely advisable to try to remove all poor-quality or diseased trees in one operation, if this would too greatly open up the canopy. Some of the undesirable trees can be removed in the second or third cutting cycle.

"Release cutting" is removal of trees or other plants that overtop the trees intended to be favored. It is most often necessary where young trees have been underplanted. Release cutting is often desirable with natural reproduction, particularly as a means of favoring one or more desirable species. Removal of wolf trees may sometimes be classed as a part of release cutting.

"Thinning" is an operation in an overdense stand of young trees. Without it, in many such stands the struggle for survival would weaken the trees and result in growth stagnation. Crop trees are selected and are freed from competition to an extent that will let them develop normally. The crop trees are nearly always selected from the dominant and codominant classes.

Tolerance

The capacity of trees of a given species to endure shade is known as their tolerance. Maples, beeches, and hemlocks, for example, are known as very tolerant trees. Ash, birch, and most pines are intolerant. White pine

and oaks are intermediate. Usually a tree of an intermediate species and sometimes even a suppressed tree of a tolerant species, if in good condition, responds to release by making good growth. Intolerant trees once suppressed rarely respond when liberated. Tolerance varies not only with species but with age and with the kind of soil in which the trees grow. Trees of most species can endure greater shade on good sites than on poor ones and can endure greater shade in youth than in maturity. It is important for anyone managing a woodland to know the tolerance characteristics of the local tree species. This knowledge is useful not only in deciding whether to cut or leave a particular tree but in deciding what method of cutting to practice in order to get reproduction of the particular species wanted. In a selection forest, only trees that are at least intermediate in tolerance can reproduce successfully. Anyone wishing to keep an intolerant species such as ash, black walnut, or locust in a selection forest must modify the selection system sufficiently to permit full light to reach the forest floor in spots where reproduction of this species is sought.

Forest Soil Management

Soil is the source of nutrition for the forest tree crop just as it is for other crops. Soil of good fertility and moisture is necessary for the best woodland growing conditions, and in well protected and managed hardwood forests the soil has a crumb structure similar to that of a good garden soil. Fertility in a woodland soil is managed partly by protective measures—for example, exclusion of fire and of grazing animals. Complete exclusion of grazing animals is not required with all kinds of woodland. The first precept is to let nature have a chance to develop the kind of soil it develops on undisturbed forest areas. Forest trees get sufficient mineral and other nutrients for their growth from soil into which leaf litter and other organic matter has been incorporated by animals, earthworms, and micro-organisms. Where conditions of moisture and temperature are right, litter is rapidly reduced to humus and is then incorporated into the soil. The decomposition process makes available the nitrogen, phosphorus, and potash needed for tree growth. In cold northern climates the decomposition of the litter proceeds very slowly and the growth response of the forest trees is accordingly slow.

Livestock in the Farm Woodland

Grazing of cattle and sheep on farm woodland areas is injurious to timber growth, except that regulated open-range grazing does little harm in most conifer types. Grazing should be controlled to the extent that will let farm woodlands make the greatest contribution to the farm economy, whether in the form of wood, forage, wildlife, recreation, or some combination of these things. Ranging of hogs is injurious to longleaf pine and to Great Plains windbreaks; otherwise, moderate use of woodland areas for ranging hogs may not be objectionable.

Grazing of livestock in conifer woods reduces the fire hazard. In mixed stands grazing animals eat hardwood leaves and brush as well as the grass. They do not eat conifer growth unless forced to do so by lack of more palatable browse. Hence moderate grazing tends to increase the percentage of conifer

seedlings. Heavy grazing can do great damage to soil and reproduction in conifer woods, as elsewhere.

Silvicultural Uses of Fire

Fire is the greatest destroyer of woodland timber and woodland soil. A good farm woodland is impossible where fires are uncontrolled. Fire not only kills young trees but scars larger trees and reduces the quality and quantity of lumber they will produce. Woodland fires also consume the litter that covers the forest soil and protects it from erosion. Nevertheless, in the southern pine region, fire has its uses in forest management. Management of longleaf pine in the South requires some use of fire to control disease of seedlings and create conditions favorable to seedling growth. Farmers and conservationists in the longleaf pine belt can learn the special practices applicable to this species from the State foresters or the forest experiment stations.

Whenever fire is used as a silvicultural tool it must be carefully kept under control. If carelessly used, it will do more harm than good. A farm woodland owner should burn only if he is well assured that benefits will outweigh cost and damage. He must take advantage of natural fire barriers, fire danger ratings, and information on wind velocity, and must not burn except at times of day when wind movement is slight and moisture conditions are favorable.

Fire is useful, also, for ridding southern pine woods of highly inflammable materials at seasons when it can be controlled. An example is the burning of logging slash in weather favorable to control of fire. This practice not only removes a fire hazard but, in some timber types, favors natural reproduction of the most desired tree species. Again, this is a local practice full discussion of which must be left to local foresters.

Getting Natural Reproduction of Pine

The cheapest and most satisfactory way of getting a new forest established is to obtain natural reproduction. For this it is essential that seed trees of the species desired be present and that a seedbed be provided in which the seedlings can grow well. For pine, the best seed tree is 12 inches or larger in diameter and has a large crown. There should be not less than six or eight seed trees per acre, well distributed. Sometimes it is a problem to keep the grass and brush that grow on cut-over areas from preventing establishment of the desired tree seedlings. Ways and means of doing this constitute a local silvicultural problem that must be studied carefully. Ideally, reproduction becomes established before the last harvest cutting.

Ecological Factors

Ecological factors considered here are natural succession of forest species and types as soil conditions improve after clear cutting or fire or both and natural restoration of forest growth on old fields. Certain species make up temporary cover types—for example, gray birch in the Northeast,

bracken in the Northwest, aspen in the Lake States, lodgepole pine in the Rocky Mountains, scrub pines on the Peidmont plateau, and sassafras, persimmon, and various shrubs on old fields in the Eastern States. These are recognized as pioneer or temporary types that prepare the soil for succeeding conifers or hardwoods or a mixture of both. These pioneer species are readily succeeded by better timber species. The farmer can speed up the desired succession by introducing at the appropriate time the better species that would naturally follow. He can advance considerably the development of better woodland types by underplanting these temporary types. The appropriate time is usually when the temporary cover has about run its course and its crowns are beginning to thin out. If natural reproduction has not taken place, underplanting at such a time followed by cutting of the overstory will often produce the desired forest stand many years sooner than natural succession would do so. Underplanting of temporary types should not be attempted when the overstory is still so vigorous that great effort would be involved in releasing the planted trees from excessive shade. Where seed trees of the desired species are available, regeneration of these species can be hastened by judicious cutting. The farmer should watch the natural processes and work with rather than against nature in order to make rapid progress in developing the kind of young forest he wants.

Selective Cutting

Selective cutting is a system under which a stand of timber is harvested in partial cuttings at intervals that may be as short as 1 year, and trees to be cut are chosen one by one on the basis of their suitability for utilization and the effect their removal will have on neighboring trees left standing. This system prevents soil erosion and preserves the productive power of the soil. It is simple to apply. If persisted in, it results in a stand in which tree sizes and ages are normally distributed.

In practicing single-tree selection for cutting, the volume of timber to be cut may be determined on the basis of the volume needed, the current productivity of the woodland, the quantity of labor available, a set number of trees to be removed per acre per year, or a combination of these factors. Thinning, improvement cutting, and other cutting practices go along with single-tree selection.

Selective cutting is primarily adapted to a woodland mostly of tolerant species, because reproduction must be obtained in slight openings and development of young trees must be obtained by gradual removal of overhead shade. Even with a stand of intolerant species, such as most pines or Douglas fir, the system can be used for a period of years until the larger trees have been removed and the smaller ones have grown into the diameter classes that will produce the most valuable products. With rare exceptions, the first planned cutting in any farm woodland should be done selectively.

Obviously, because of differences in site quality or forest type, some portions of a stand may be permanently adapted to selective cutting and others to some form of clear cutting. For example, one part of a stand may be pure

bottomland hardwood, which may be managed permanently on a selective-cutting basis, and another may be mixed pine and hardwoods, in which, because the pine should be favored, a better method is to clear cut on small areas.

Conifer stands vary greatly in suitability for selective cutting. Even the same species must be dealt with differently in different parts of its natural range. Some species can be managed successfully by selective methods only for limited periods, and must be managed otherwise when reproduction is sought. Commercial forestry practice often calls for removing 60 percent or more of the volume of a stand in one cutting and removing the remainder after 5 years, when reproduction has become established. Such a method does not fit into farm woods management, because income is not evenly distributed. Local silvicultural experience is the only safe guide.

Clear Cutting

Clear cutting, in general, is poor management of the farm forest soil. It should be resorted to only when the nature of the forest or the owner's purposes require it. Prevailingly, young trees will not grow under the shade of other trees; they must have light. Often tolerant hardwoods start under pine, but here the farmer wants pine, not hardwood, reproduction. He must clear cut the pine in order to get pine reproduction and give it a chance to grow. (Carefully controlled grazing may help.) Otherwise the forest will eventually be taken over by hardwoods that are unprofitable. Likewise, satisfactory tree reproduction does not occur naturally under stands of oak or of Douglas fir. Even in northern hardwoods, the selective system of cutting must be modified in order to encourage such light-demanding species as ash and black walnut.

The farmer should sacrifice the advantages of the selection forest as little as possible. He should clear cut only a small area at any one place and time—1/4 acre or less where this will be sufficient and never more than 5 acres. Once an area is cut over, he should use every device to obtain a vegetative cover of the desired species as quickly as possible. Often it is desirable and feasible to plant trees in clear-cut patches rather than wait for the slower process of natural reproduction.

Pruning

Tree pruning is removal of limbs, living or dead, in order that the standing tree may become more useful or that the products to be obtained from it may be greater in amount and better in quality. It is usually confined to conifers. The length of stem pruned should never exceed two-thirds of the total height of the tree. Usually the best procedure is to prune the trees to a height of 10 to 16 feet when they have reached diameters of 4 to 6 inches and later, before they have become 8 inches in diameter, to prune them to a height of one or two 16-foot logs.

The number of trees to be pruned depends upon how thorough a job is desired and how much labor is available. It is impossible, of course, to select at the time of pruning the exact trees that will be the final crop trees. Therefore, to insure that every final crop tree will have been pruned, it is

usual to prune a number of promising, evenly spaced trees equivalent to 200 per acre at an average diameter of 6 inches. Some of the trees pruned under this system that do not become final crop trees are cut for poles or small sawlogs, so the effort of pruning them is not wholly lost.

According to the Southern Forest Experiment Station, the pruning of crop trees in dense stands promises to increase the value of the harvest $100 or more per acre. High-quality saw timber, in most cases, brings a considerable premium over "woods run" stumpage values. Since logs of No. 1 grade are worth about 4 times as much as those of grade 2 and from 6 to 20 times as much as those of grade 3, the practice of paying a premium for high-quality timber is certain to become firmly established. Therefore, the farmer should always try to grow straight, clean-boled trees that will produce high-quality timber rather than a large volume of low-quality material.

CHAPTER VI. DEVELOPING A FARM WOODLAND ENTERPRISE

If the advance farm planning has been done well, the farmer knows a good deal about the first things to be done in developing his woodland. The planner has pointed out to him the work that is needed and details of the operations: for example, the mature, defective, crooked, and wolf trees that should be cut, the manner of felling that will protect the desirable young growth, methods for getting closer utilization, and measures to reduce fire hazard and grazing damage; also, the kinds of trees that should be used for firewood, fence posts, and logs to be sawed into lumber for use on the farm, and the trees that should yield surplus products for sale.

In carrying on his woodland enterprise the farmer will have many opportunities to develop his own ideas and to perfect his techniques. He will find it necessary to vary his cutting as his growing stock changes. He needs help and encouragement from time to time in marking trees for cutting and in arranging to sell any surplus beyond his own needs. He may appreciate advice about utilizing trees and logs so as to produce the greatest values. Helping him to do these things requires some fundamental understanding of forestry principles, but is relatively simple. This work is often done by conservationists of subprofessional grade.

The prospect may look discouraging at first. The woods may be full of such species as choke cherry, scrub oak, gray birch, or beech and cull trees of desirable species. However, improvement cuttings can remove these and leave better trees dominating the stand. Old-field stands of pine that, because of wide spacing, had become very limby have been converted in 10 years' time, through selective cutting and pruning, to stands with fairly clean boles. Nature responds well to intelligent use of the ax.

Farm woodland, like any other cropland, produces yields and values in accordance with the care it receives; the value of what is taken from it is proportionate to the labor and money spent on it. A difference between forest land and corn land, for example, is that forest land does not require fertilizer, manure, lime, or other soil amendments. The woodland requires

time to develop and expenditure of labor in cutting according to a plan of management. In the average depleted woods, time is required to build back what has been destroyed over a long period. How many years are required to bring a depleted farm woodland up to full producing capacity depends upon how badly the woodland growing stock has been mistreated and how far back in the scale of development the farmer has started his planned management.

The growing stock of trees must first be developed by planned cutting, cultural treatment, and sometimes planting; then it must be maintained in order to get sustained, regular harvests. The farmer, and the farm planner who advises him in its development, must know the characteristics of a good growing stock and the factors that are influenced by systematic treatment.

So long as the plan of a woodland enterprise provides for good forestry practices, continued technical assistance to the farmer from public agencies is justified. At some stage, the farmer may need help of so detailed a character that he should normally expect to employ a technician on a fee basis in order to get satisfactory and complete service.

Development for Multiple Use

If the woodland plan for an area in the north woods containing some sugar maple calls for developing a sugar bush, the cutting is done in such a way as to favor the maple trees without sacrificing too many thirfty immature ash, birch, or oak trees. If most of the acreage of the woodland is needed for production of wood and only part of it is to be converted to sugar bush, planting of sugar maples on adjacent open land may be a part of the management procedure. Where a woodland within the range of longleaf and slash pine is to be operated for naval stores, this intention may not have any radical effect on cutting but may mean encouraging natural reproduction of the naval stores pines at the expense of associated tree species or planting such pines. It may also mean unusual fire protection measures and possibly the use of fire as a silvicultural tool.

If the protective influence of woodlands is the thing chiefly sought in management, cutting is very conservative. Cutting may be varied so as to leave dense stands where protection is most needed and light stands on other portions of the woodland. To obtain protective benefits small areas within old stands may be clear cut and planted; for example, to gain greater wind protection a strip of overmature hardwood timber may be clear cut and the clearcut area planted to conifers.

Where possible, a variety of tree species should be grown. Farm needs call for a wide assortment of products, and variety in the products offered for sale means greater opportunity to take advantage of changing markets. For example, white oak is a useful tree on the farm and its wood is in demand for a wide variety of uses industrially, but white oak does not normally grow best in pure stands. When a woods contains a variety of tree species, the trees are less liable to severe injury from winds or from insects and fungi. A farmer may wish to grow yellow poplar, but unless his site is suitable for that species the effort would not result satisfactorily. Even on a site suitable for yellow poplar, a mixed forest will produce more satisfactory

yield and income. On a particular site the farmer may have to be satisfied with pin oak or swamp oak instead of red oak or poplar. For some of the pines and Douglas fir, which naturally grow in pure stands, it is sometimes wise management to encourage or try to introduce a mixture of other species. Some of the broadleaf shrubs are desirable as an understory, because they improve soil conditions.

Management Methods

Cutting cycle.—The planned interval between one cutting and the next on the same area under systematic forest management is known as the cutting cycle. Usually, both for economic and for silvicultural reasons, it should be a period of several years. For farm woodlands a 5-year cutting cycle is usually recommended. With such a cycle, each cutting removes the growth accumulated in 5 years.

Woodland subdivisions.—Management is sometimes made easier by dividing the woodland into blocks of the same number as there are years in the cutting cycle and cutting over one of these blocks each year. This procedure, of course, simplifies logging, hauling, and supervision. It is highly recommended for situations where it can conveniently be applied. To be managed successfully in this way, however, a woodland must have a rather uniform stand. Such an arrangement is not practical if the stand is uneven because of differences in type, site, quality, or age class. It may be hindered, also, by difficulty in marketing certain products in small quantities.

Volume and growth estimates.—In most farm woodlands, especially where the farmer has adopted the principles of integrated farm forestry, cruising of stands to determine volume and studies to determine growth are not essential to good management. Where a farmer is practicing, or proposes to practice, a commercial type of forestry, determination of the volume to be cut and its value may be essential and consequently complete cruising of the stand and often a determination of growth may be needed. This is level 3 assistance, which the farmer should obtain by paying a fee. Estimating volume on limited areas in order to determine the amount to cut in terms of products to be obtained and in terms of labor requirements is helpful, and often is required. Application of rules of thumb to determine what proportion of the dominant trees should be removed periodically may suffice for some forest types. In integrated farm forestry a knowledge of the rate of growth is not necessary during early stages of management but may be needed later. In the later stages of woodland management the owner usually wants to learn to use volume tables and some one of the several cruising sticks available. These tools enable him to estimate volumes in particular trees or stands in such units as cords, linear feet, and board feet. With such estimates, arrangements can be made in advance of cutting for use or sale of the products. A farmer selling wood products should know how to use the log scale stick and lumber tally stick.

Standard rates of growth.—As an aid in judging the rate of growth on well-stocked forest lands, here are a few general averages of annual increase in board-foot volume of timber:

Forest type	Annual growth per acre Board feet
West coast Douglas fir	2,000
Good southern pine	800
Southern hardwoods	200 to 400
Northern hardwoods	150 to 300

These values do not include materials removed from tops or in intermediate cuttings—thinnings and salvage cuttings—primarily intended to give better spacing to crop trees. Such materials are often almost as important as the final board-foot yields.

Rules of thumb.—If the farmer can get the advice of a forester trained in measuring timber volumes and calculating timber growth, he should follow this advice in deciding the number or volume of trees to cut from his woodland. If not, he should endeavor to cut material suitable for making pulpwood, fuel, posts, or ties in such a way as to give ample space to the crop trees. A rule of thumb found applicable in southern pine-hardwood and some other forest types for spacing crop trees is known as "D + 6." Under this rule the breast-height diameters, in inches, of any two neighboring trees are averaged and the desired distance in feet between the two trees is found by adding 6 to the result. For example, the desired distance in feet between a 10-inch and a 16-inch tree is calculated as $\frac{10 + 16}{2} + 6$, or 19, and that between a 7-inch and a 9-inch tree as $\frac{7 + 9}{2} + 6$, or 14. If trees are left standing closer than this they will need more growing space before the next cutting. In addition to the trees removed to bring about this spacing, in each cutting under the D+6 rule one of the largest trees on each acre should be harvested for each year since the last cutting. In a well-stocked 40-acre woods cut over annually, this practice means cutting a total of 40 trees every year or 200 trees every 5 years. This rule is intended to leave the stand in condition, after each cut, to close its canopy before the next cut. Other forest types require different spacings, which should be determined locally.

A rule of thumb sometimes used where a forester has determined timber volume in board feet is never to cut more than 20 percent of the merchantable volume of the growing stock in any 5-year period. For example, if the volume of the trees 12 inches or more in diameter amounts to 7,500 feet log scale per acre, not more than 1,500 feet should be cut in 5 years. In fast-growing stands that is conservative; in slow-growing stands, it is likely to mean too heavy a cut. The estimate of merchantable volume used in applying this rule does not include posts, fuel wood, or other small products removed to give the crop trees more room. If cutting is done on the basis of careful selection of trees to be removed with the purpose of producing fairly regular wood harvests, experience will soon indicate safe cutting limits.

CHAPTER VII. EXAMPLES OF WOODLAND MANAGEMENT

To illustrate procedure in developing the growing stock of a farm woodland, typical examples are presented here of conditions in actual stands and silvicultural measures applied. For the most part, as a matter of convenience, hardwood problems and conifer problems are discussed separately, although mixed stands are not uncommon and in practice the methods described here separately will sometimes have to be combined.

Farm Woodlands Predominantly of Hardwoods

A. Trees have been injured by overgrazing or by fire, and the soil has been seriously damaged.

Protection is needed to restore the litter and humus and then to establish reproduction. Plowing or discing the ground may hasten natural seeding. Planting of seed or seedlings may be advisable, to improve the density and composition of the future stand. All cutting operations must be conducted in a way that contributes to the basic needs of the woodland.

1. Hardwood trees on sloping land so severely grazed that the litter, the humus, and even the topsoil have been destroyed by erosion.

Regardless of the character of the stand of trees remaining, such a woodland has poor prospects. The trees do not grow at a normal rate, they are weak because of the poverty of the soil, and they are easy victims of insects and fungus diseases. Unless protection from grazing is given before the soil is completely wrecked, the next stand likely will be scrub growth. The site will no longer be suitable for desirable hardwoods. Cutting, if any, must be very light until the soil is restored.

2. Overmature, scattered hardwood trees on a level or nearly level area severely grazed.

This woodland is in the last stages of conversion to pasture, yet there is too much shade for good pasture. The soil is not seriously injured by erosion, because grass has covered it and because the slope is gentle. The soil is hard and compact. Winds sweep away the leaf litter and dry out the soil. Growth of the trees is practically at a standstill, and there is no reproduction. It is not too late to restore good physical conditions. If grazing animals are completely excluded, nature can reestablish a good forest soil, and reproduction will follow. Discing the soil and interplanting will hasten the process. Only dead and dying trees should be removed until young growth is firmly established.

Such conditions as these are often found in sugar maple orchards. Yield of sap is less than on a good forest soil, and sooner or later such a sugar bush will come to the end of its profitable career because there is no reproduction. Under protection, sap yield will increase and young trees will come in to replace the old ones. Weeding the young stand before it reaches the sapling stage will ensure a high percentage of sugar maples.

3. Hardwood stands damaged chiefly by overcutting, not seriously affected by grazing or fire.

a. A thin, scattered, irregularly spaced young stand on a good site. Protection will permit the young trees to grow. Reproduction will come from seed and from sprouts. Weeding of the young stand to increase the proportion of good species, even though it produces no merchantable material, will pay dividends in the long run. So far as possible, weeding should always be done where it will produce usable material such as fuel or posts.

b. Cutting has removed the best trees from a good site. The remaining trees are all undesirables, mostly of medium and large size. Some open spots appear.

A market for products that can be made from the trees remaining is about the only salvation. Under protection from fire and grazing, abundant reproduction from seed and sprouts can be expected wherever the stand is sufficiently open. Cutting to enlarge the openings should be given first priority. As heavy a cutting schedule as market and labor conditions permit should be adopted. Weeding and release cutting should follow, as the young stand grows. Conditions are discouraging, but regular cuttings will gradually lead to development of a worthwhile growing stock.

c. Hardwood sites of low grade, either naturally or because of mistreatment, on which cutting has gradually eliminated the best trees and left a thin stand of poor trees. The remaining trees may be of good species, but they do not promise any products of much value.

Since pine trees can develop into valuable timber on sites where hardwoods grow very poorly, interplanting of pine seedlings is suggested. White pine should be used in the North, shortleaf or loblolly pine in the South. (This practice is not feasible on good hardwood sites, because of the vigorous growth of hardwoods.)

B. Hardwood stands ready for improvement.

1. Dense stands of sprout hardwoods that have developed within a period of about 20 years after clear cutting.

Treatment of dense sprout stands takes the form of weeding and release cutting. Crop trees should be selected among the straightest, most evenly spaced sprouts of best species originating near the ground line. Sprouts from small stumps usually are more desirable than those from large stumps. Only fuel and posts can be expected from the first cuttings. Second and later cuttings will yield also pulpwood, poles, and sawlogs.

2. Pole stands of hardwoods.

Cutting in pole stands of hardwoods, that is, stands of hardwood trees 4 inches but not more than 8 or 12 inches in diameter at breast height, should aim at proper spacing of crop trees. Stimulation of growth resulting from cutting should permit continuous selective cutting at intervals of about 5 years. Reproduction comes as cutting proceeds. The "D ∠ 6" method has proved very helpful in marking such stands.

Pole stands vary greatly, owing to site differences, fires, overgrazing, and other misuse. Management of pole stands composed of trees of good species and form on good sites presents no problems. It should aim at producing maximum output of sawlogs when the trees reach appropriate size. On poor sites, selective cutting is made difficult by the presence

of many defective trees and trees of inferior species. Proper spacing is harder to attain, and marking timber to get best results over the long pull requires close attention to tolerance and other species characteristics, form, site quality, and the position of the crowns of crop trees in relation to those of their neighbors.

3. All-aged pure hardwood stands.

An all-aged pure hardwood stand has a good distribution of size classes, from reproduction to mature trees 20 inches or more in diameter. It contains a good representation of native species. It is likely to have some trees of species the wood of which is hard to sell or use, such as hickory, beech, ironwood, and elm. Occasionally a stand arrives at this condition because the owner values his woodland and cuts very cautiously. Such a stand may be put under a sustained-yield cutting program at once if this is consistent with farm economy.

In drawing up a cutting schedule three things should receive first attention: (1) If, as is usual, the reproduction is mostly of maple, elm, beech, and hickory, and young growth of white and red oak, ash, basswood, and cherry is sparse, cut so as to admit more light to the forest floor in favorable spots. (2) Get all or most of the farm wood requirements from thinnings and other improvement cuttings. (3) Apply some rule of thumb to determine what amount of products or how many trees shall be removed in each harvest cutting. One rule is to cut in any 5-year period not more than 20 percent of the board-foot volume in trees 12 inches or larger in diameter at breast height. This means cutting about one-fifth of the total number of such trees in the woodland in 5 years' cutting or about 1 out of every 25 each year. Another rule is to thin by D $\neq$ 6 and cut 1 crop tree per acre each year.

These are conservative guides. If the farmer is intent on cutting all possible wood volume, he needs help from a consulting forester working on a fee basis.

Farm Woodlands Predominantly of Conifers

A. Conifer stands damaged chiefly by overcutting.

1. Clear-cut pine woods. A clear-cut pine woods is usually a result of a lump-sum sale. Burning of logging slash left by clear cutting effectively disposes of that fire hazard but also destroys most of the young trees that escaped the ax.

A slow process of building back must begin. The fire problem needs first consideration. Firebreaks may be required. If sufficient seed trees remain, natural reproduction may be expected. If not, planting is the next step. Even with natural reproduction, the farmer may want to do some planting either to introduce other species or to insure full stocking.

Perhaps some cutting is possible, to salvage material not destroyed or to develop parts of the stand left by the cutting and fire. In any case, the farmer faces a relatively long development period before much return can be expected.

2. Situations in which merchantable material has been removed and young growth left, untouched by fire.

Here the farmer has something to work with. He can begin thinnings and improvement cuttings, perhaps some pruning. Crop trees less than 8 inches in diameter, if they have so much space between them that the stems are not clear of lower limbs, may be pruned. A schedule of cutting material for home use, at least, can be undertaken.

B. Conifer stands ready for some form of improvement cutting.

1. Scrub pine in old fields.

Scrub pine growing up on old fields has the mission of partially restoring forest soil conditions. Management should aim to help nature substitute better species of pine and to allow hardwoods gradually to come in. Three distinct operations are advisable:

a. A harvest cut of merchantable material (any product) in small clear-cut patches ($\frac{1}{4}$ to $\frac{1}{2}$ acre). Plant a better pine in wide spacing (8 to 10 feet), which will allow scrub pine and some hardwoods to seed in.

b. Thin other parts of the stand, not ready for harvest cut, on a crop-tree basis.

c. Prune crop trees less than 8 inches in diameter. Gradually the entire stand will be cut, and as a result the scrub pine will be replaced by a mixture of better pines, hardwoods, and some scrub pine that will last through another generation. In hardwood country such sites will eventually be taken by hardwoods unless the pines are aided through management. The cutting schedule can conform largely to the requirements of farm economy and market conditions.

CHAPTER VIII. ESTABLISHING NEW WOODLANDS BY PLANTING

Gullied Areas

Tree planting has distinct value as a means of gully control. It does not give the quick control of gullying that is often needed, and must be supplemented with other measures. Trees become completely effective in controlling erosion when they form a closed canopy and deposit an ample layer of litter on the soil. By planting trees in gullies the farmer may get revenue from such products as Christmas trees, posts, fuel, and pulpwood and—later on—from the higher-grade wood products.

Extensive experiments in controlling gullies by use of vegetation and engineering structures were carried on by the Civilian Conservation Corps from 1933 to 1942. Protection from fire and grazing was found to be the most

important means of restoring vegetation and controlling erosion on gullied areas. Unless such protection is given continuously, any attempt at control is useless. If a good barbed-wire fence is put up to keep out livestock and the necessary precautions are taken to protect the gullied area from fire, nature will gradually bring in trees, shrubs, and grasses of the species best adapted to the site and, in most cases, the gullies will eventually be healed. However, natural processes are slow and offer little chance that the present landowner will ever obtain much return from the expense he incurs in controlling gully erosion. There may be some revenue from wildlife, but this likely will be small.

In an attempt to bring gullied areas into profitable production at an early date, the CCC planted black locust extensively. Many of the locust plantings failed completely. We now know that black locust is adapted to only a limited number of soil types, usually those of loose texture and good drainage and moisture conditions.

These are the measures that generally prove successful in gully control:

a. Protection from fire and grazing.

b. Temporarily diverting water until vegetation becomes established.

c. Mulching the surface with slash from tree tops, brush, straw, or other materials.

d. Seeding grasses on a properly prepared and fertilized surface.

e. Planting trees. Black locusts are desirable where they are adapted; elsewhere pines, usually scrub varieties, are most successful. Trees should be planted on the slopes of a gully and at its head, but not in the main channel. In the main channel shrubs, grasses, and other vegetation that will not obstruct the flow of water are most useful.

f. Placing across the channels temporary dams of various kinds such as burlap sacks loaded with a mixture of soil, grass seed, and fertilizer or dams made of wire, posts, logs, brush, and rocks.

g. Building concrete structures to hold back the sediment-laden waters so that the sediment will be deposited. This is expensive, and even the best concrete structure is relatively temporary and will do no permanent good unless supplemented by a vigorous growth of vegetation.

Stream Banks and Dams

To control erosion of stream banks, it is customary to plant trees—often willows—and shrubs. Frequently cuttings are used. Sometimes some type of mulch is held in place with mechanical structures for temporary control until the vegetation can become established and form a living obstacle to the washing effect of the water. Vegetation usually serves the purpose best if kept in the most flexible condition, so that it will bend with the current. Trees

are often planted on top of stream banks, also, to deflect the current at high water stages.

Planting about dams is usually done with shrubs and such trees as willows and cottonwoods.

Road Cuts

It is hard to establish vegetation in road cuts, because of the steepness of the slopes and the low fertility of the soil. Trees have a very small place in road-bank control; usually grass, vines, and shrubs are more useful. In many localities pine trees seed naturally and grow well on road cuts. They should be encouraged, unless they will create a traffic hazard by obstructing the view.

Windbreaks

In the Great Plains, tree planting for control of wind erosion and protection from cold and heat has been practiced since 1934 with Federal and State aid. Tree planting has been practiced by farmers here and there in this region since the earliest white settlement. Windbreaks have proved useful for protecting farmsteads and field crops throughout the Plains and also in many of the northern States where wind erosion is not a factor but protection from cold and hot winds adds greatly to the comfort of farm life. In addition to giving protection, many windbreaks supply fuel and posts for farm use. In the driest parts of the Plains, except on irrigated lands, farmstead windbreaks are about the only purpose for which tree planting is generally advocated, because of the extreme care necessary to keep the trees alive. Such windbreaks are commonly planted on one or two sides of the farmstead; in some cases, they are planted on all four sides.

A windbreak may be a single-row hedge of hardwoods, one or more rows of conifers, or a combination of hardwoods, conifers, and shrubs. The main part of the typical windbreak is hardwood trees, which are supplemented with one or more rows of conifers and shrubs. In the early stage of the Prairie States Forestry Project, many windbreaks were established with a width of 10 rods or more; later, the 5-rod width was more popular.

On land of high value a windbreak should contain only one or two rows of trees, so as to occupy the least possible space. On irrigated lands in southern California and Arizona, a single row is used. Where yields of fuel and posts are required, windbreaks should be wider than elsewhere. Local specifications to fit various climatic and soil conditions and various farm needs are supplied by State and Federal agencies.

Species generally successful in Plains shelterbelt plantings include elms, ashes, cottonwood, black and honey locusts, hackberry, and such shrubs as Caragana, Russian-olive, lilac, and squaw bush (Rhus). The conifers commonly used are pines, cedars, and spruces.

The essentials of success in establishing windbreaks are (1) using adapted strains of trees and shrubs; (2) careful site preparation; (3) careful handling of planting stock, from the nursery to the planting site; (4) protection against fire and grazing animals; and (5) cultivation several times each season for several years after planting. The first item means that the seed used must have originated in a locality where climate closely resembles that of the planting site.

Sand Dunes

Tree planting has an important part in efforts to stabilize sand dunes. Before trees are planted on dune areas, the dunes must be partially stabilized by use of temporary slat fences and planting of beach grass and other adapted grasses. Usually only conifers are planted extensively. Sometimes cottonwood is planted as a temporary cover. The plantings must be protected from fire and grazing.

Old Fields

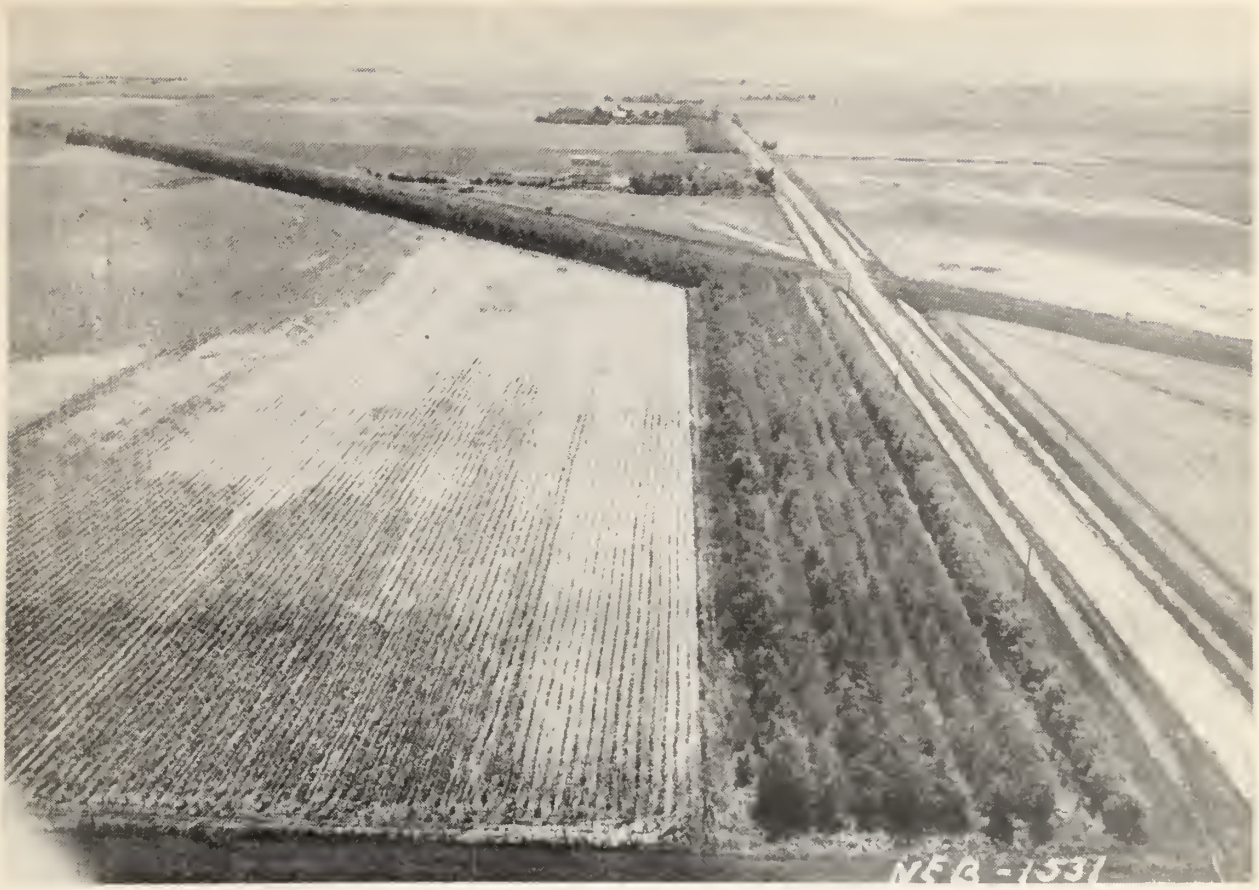
The quality of old fields as sites for tree planting varies owing to differences in soil erosion, exposure, and the character of the plant cover. A few old-field sites are suitable for planting of locusts and other post species. For the others, pines are usually selected. The pines act as nurse crops, gradually improving the sites. On some areas hardwoods may be expected to replace them. Whether hardwoods can be planted successfully on an old-field site depends sometimes on whether the farmer is willing to spend a good deal of labor on preparing the site and caring for the planted trees.

Post Lots

For production of posts, trees of species known to produce durable post material are planted usually on the very best sites on the farm, in order to get early yields. Trees commonly planted for post production are locust, catalpa, Osage-orange, and cedar. Other species are sometimes selected because of adaptation to local conditions. The plantations abe carefully cultivated. Growth of locust can be stimulated by applying a commercial fertilizer, especially one having a high phosphorus content. Since high yields and quick returns are expected from trees planted for post production, it is worth while to do everything possible to hasten their growth.

Christmas Trees

New woodlands for production of Christmas trees can be established by any one of several methods. By protecting and managing natural reproduction on cut-over lands and along the edges of woodlands, Christmas trees can be produced either as the final crop or as intermediate crops derived from weedings and thinnings. Trees may be planted on old-field or cut-over areas without site preparation and cut for Christmas trees as either the final or an intermediate crop. Probably the best results, and certainly the quickest, are obtained by planting on the best sites with proper soil preparation and



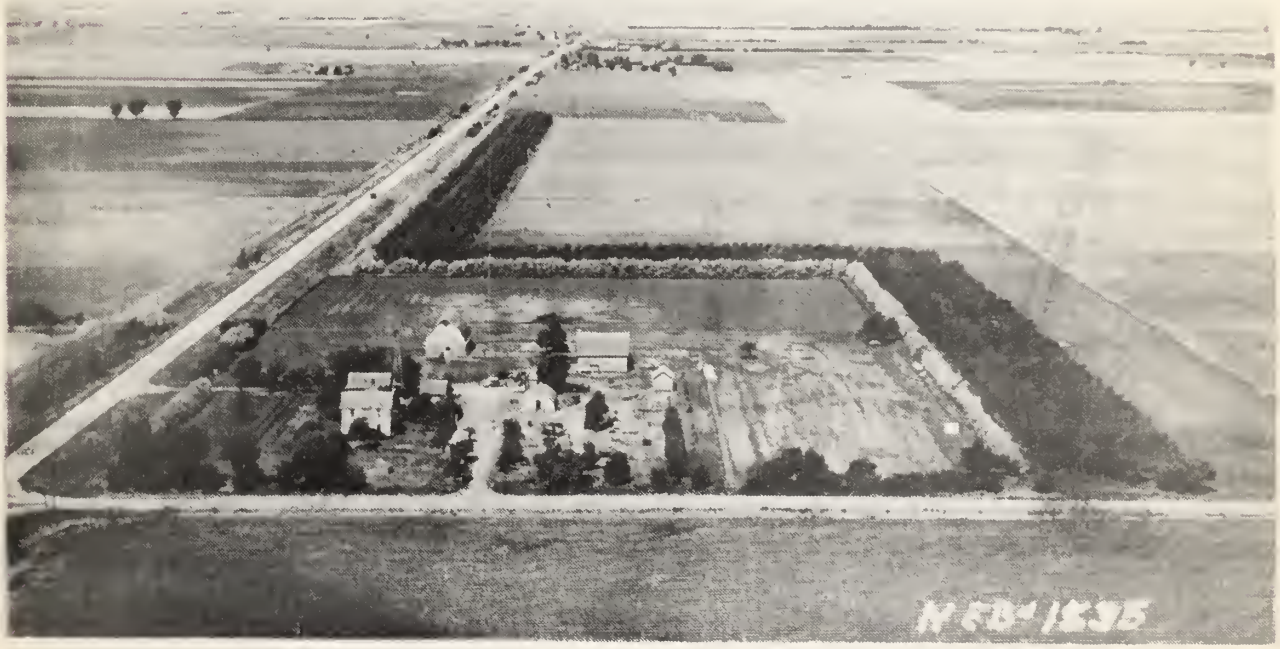


Figure 5--A ten-row field windbreak one-half mile long for protection of field crops on a farm in Nebraska.

Figure 6--A combination farmstead and field windbreak for protection of buildings, garden, feed lot, and field crops.

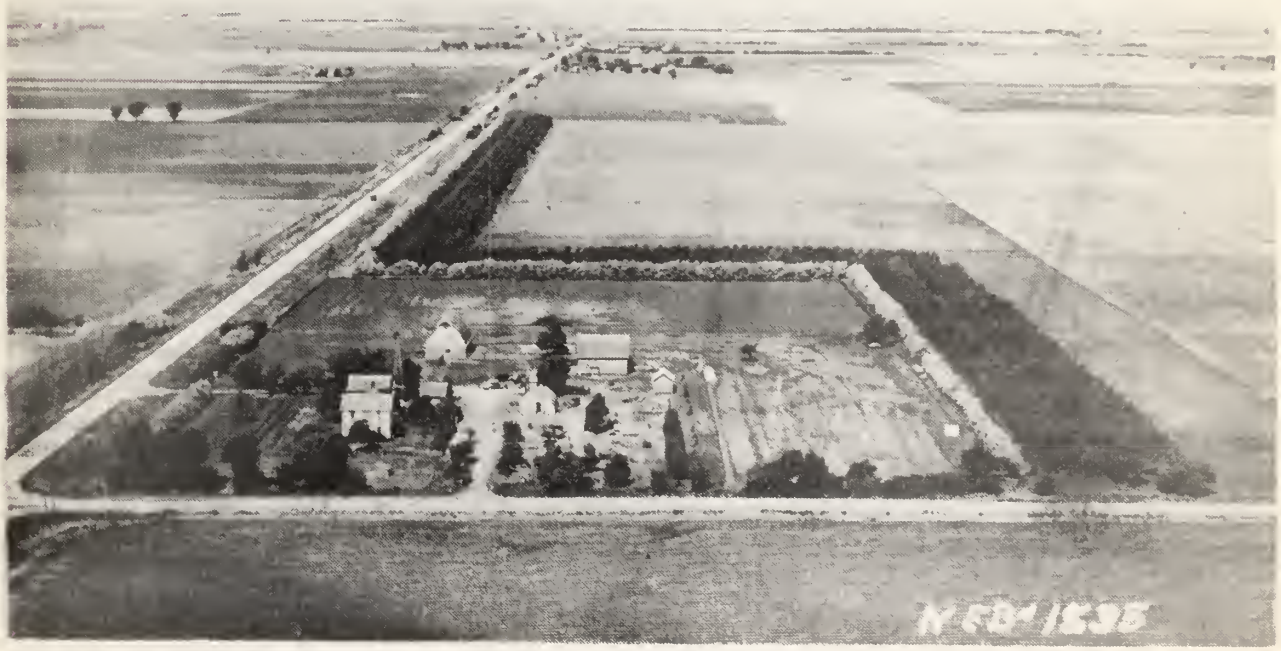


Figure 5--A ten-row field windbreak one-half mile long for protection of field crops on a farm in Nebraska.

Figure 6--A combination farmstead and field windbreak for protection of buildings, garden, feed lot, and field crops.

careful cultivation. White pine, Scotch pine, white spruce, Norway spruce, balsam fir, and Douglas fir are the trees most commonly planted for Christmas trees.

Tree Planting Procedure

Choice of species.—Choice of tree species for establishing new woodlands is a local question, to be answered on the basis of soil, exposure, erosion conditions, and experience with previous plantings. The general principles of ecological succession have a highly important bearing on the desirability of a species. In general, hard pines and scrub pines are suitable for the least favorable sites. Black locust will succeed on some eroded sites where other hardwoods would fail. So far as present knowledge indicates, it requires sites with loose-textured soil, good moisture conditions, and good drainage. Locust will grow on soils low in fertility and organic-matter content. It is a leguminous plant, and in soil infected with certain bacteria it contributes to adding nitrogen to the soil. Most other commercial hardwood species succeed only on soils containing normal quantities of plant nutrients and organic matter. Plantations of the better pines and the hardwoods usually require good site preparation and care. Hardwoods, especially, are more likely to succeed if cultivated and sometimes if weeded. They may be grown successfully by interplanting among hard pines and scrub pines, which tend to prepare the site. On the other hand, experience indicates that it is useless to plant pines on a good site where vigorous hardwood sprout growth is expected. Hardwood sprouts will crowd out pines, unless the farmer can find a way of releasing the pine trees from the competing sprouts through carefully managed grazing or otherwise. Pine and locust mixture does not succeed.

Production and care of planting stock.—Correct selection of seed from which to produce tree planting stock has an important bearing on the success of the planting. It not only affects the capacity of the trees to grow in the climate of the planting site but may vitally affect the character of their growth. We know that black locust trees vary tremendously in accordance with characteristics of the parent trees. Likewise, many Scotch pine plantations in the United States have failed to develop satisfactorily because the source of seed was not well selected. Tree seed for planting should come from parent trees of good quality growing in localities where the climatic conditions closely resemble those of the planting sites. Farmers and conservationists can guard against unsatisfactory seed selection by (1) insisting on a statement from the seller of stock as to the source of seed, (2) buying only from nurserymen they know to be reliable, or (3) collecting seed locally and growing their own seedlings. The third course is perhaps the surest. Often a farmer who adopts it can sell any surplus tree stock at a good profit.

Risk to the planting stock is involved not only in the actual planting operation but in the handling of the stock between nursery and planting site. Mishandling can easily result in ruin or serious impairment of the stock's vitality. Too often the stock is improperly packed, packing is delayed after the plants are lifted from the nursery beds, transportation is delayed, or the stock is improperly handled at the heeling-in bed. Any of these things

may cause the stock to lose too much moisture or to be heated or frozen. Most of them are often beyond the farmer's control, and the injury caused to the stock is usually hard to detect.

The best defense against such risks is to produce or procure stock of good quality and suitable origin, near the planting site, and then plant it as promptly as possible and as rapidly as careful planting procedure permits. Instructions, adapted to local conditions, for handling and planting the stock are provided by State and Federal forestry organizations and by Soil Conservation Service forestry specialists.

Site preparation.—The common practices of site preparation are these:

1. Complete plowing and harrowing of the area. This is usually done before planting a windbreak or post lot and is sometimes done before planting Christmas trees.

2. Discing. This incorporates the sod of old fields into the topsoil. It is reflected in better growth of the planted trees.

3. Plowing furrows in which to plant the trees. This facilitates planting and increases tree survival. It has the disadvantage that the trees are likely to be placed in barren soil, and the initial growth rate is likely to be less than after site preparation by other methods. On steep land or land covered with high weeds or bushes it often is the only practicable method of establishing a successful tree plantation. Good results with hybrid poplar are reported to have been obtained by turning the sod into the furrows in which the trees were to be planted.

4. Mulching and fertilizing. Mulching, although expensive, is well worth while. Fertilizing of commercial tree plantations is considered necessary only for black locust. Plowing and sloping of gully banks have been practiced extensively, but the results do not seem to justify the expense. In western Tennessee these practices and even dynamiting of the banks have apparently had little effect on the growth of planted black locust.

Planting methods.—Planting machines have been used very successfully where trees were to be planted on long stretches of land free of surface obstructions, such as Great Plains areas. Their use reduces planting costs wherever the land can be plowed with tractors and other heavy equipment. Two men are required on the ordinary 2-row tree-planting machine, in addition to one on the tractor and one acting as tender. This crew can plant at least 2,000 trees per hour. Recently a new type of planting machine has been demonstrated successfully in Wyoming that is considerably more flexible and better adapted to small plantings. This machine requires only one operator and plants only one row at a time.

Hand planting of trees requires several different types of tools. In light, sandy soils, a dibble or planting iron can be used successfully for planting conifers, by planters trained in its use. Under some conditions

spades or round-pointed shovels must be used in planting hardwoods, because of their long root systems. On hard soils, especially in the Plains, tree planting is facilitated by subsoiling in the rows to be planted. This loosens the soil to a considerable depth and saves labor in planting. The mattock is the most trustworthy tool for planting trees on cut-over lands or where rocks or roots and rough terrain are encountered.

Seed spotting.—The seed of some trees can be planted directly where the tree is to grow. Where it can be practiced successfully, this is the cheapest and most satisfactory method. It is recommended chiefly for trees that produce acorns or nuts, such as oak, hickory, chestnut (blight-resistant varieties only should be planted), and walnut. Osage-orange, also, has been successfully established by planting the seed. Seed spotting should be done only on sites known to be suitable for the species. The sites may be good cleared land, cut-over hardwood forest land, open spots in hardwood forests, or land along edges of woodland where reproduction of hardwood trees may be expected to start readily. Rodents are the chief obstacle to success of such planting. Where the site is suitable and rodents do not constitute a major hazard, this is a satisfactory method of replanting fail spots. Late spring seems to be the best time for seed spotting, because then rodents are less likely to find and destroy the seed.

Acorns or nuts to be used for seed spotting should be collected in the fall and stored over winter. Directions for winter storage can be obtained from any State or local Federal forester. The principal requirement is to keep the seed at a cool but above-freezing temperature and moist but not wet. It is usually recommended that the seed be placed in layers in moist, well-drained sand. Either a ventilated cellar or underground storage is satisfactory.

Since acorns are highly subject to damage by weevils, two should be planted in each spot. Walnuts and other nuts should be planted singly. Nuts can be pushed into soft ground with the heel. They should be planted at a depth about twice the diameter of the seed, and the soil should be pressed firmly over them.

Spacing.—For windbreak purposes, trees and shrubs are usually planted 3 to 16 feet apart in rows 8 to 16 feet apart. The closer spacing within rows is used for shrubs along the outside edges of the windbreak. In low-rainfall areas where cultivation of trees must be continued for long periods, the spacing is sometimes wider. For field and gully planting, the standard spacing is 6 by 6 feet. In the South, with southern pines, this is often increased to 8 by 8 feet. Trees planted to provide cover quickly for stream banks, dams, and gullies may be spaced 3 by 3 feet or sometimes even closer.

Cultivation.—Windbreak plantings in the Great Plains must usually be cultivated from three to five times a season for the first 3 years or until their crowns begin to close. Under very dry conditions, cultivation may be required even longer. On light sand subject to blowing, no cultivation is recommended. Post lots frequently are cultivated for a few years. Other tree plantations are not ordinarily cultivated, but cultivation always aids in tree establishment.

Survival Checks

The only accurate way to measure the success of a planting is to determine periodically the number of living trees--usually expressed as a percentage of the number planted. What survival percentage is considered satisfactory depends upon the purpose of the planting. Where erosion control is the chief purpose, a low survival may be satisfactory if natural vegetation has come in, supplementing the planted trees. In commercial plantings, at least 70 percent survival is usually considered necessary; in windbreaks, 90 or 95 percent is desirable, because any break is a serious defect in a line of trees intended as a wind barrier. Any replanting that is necessary should be done the next year after the original planting if possible, and not later than the third year.

Sources of Planting Stock

Many States make tree planting stock available for farm use at reasonable prices. The Department of Agriculture, through the Forest Service, helps finance the growing and distribution of farm forest planting stock with funds appropriated under the Clarke-McNary Law. The Soil Conservation Service can sometimes supply planting stock to soil conservation districts for erosion-control planting. Commercial nurseries sell trees to soil conservation districts in wholesale lots. A few districts maintain their own nurseries. Commercial nurseries are gradually increasing their supplies of planting stock. Reliable, well-stocked commercial nurseries are a practical source of supply, especially where orders can be given a year or longer in advance.

The availability of planting stock from various sources needs to be determined locally through State or Federal forestry officers or through the local county agent.

Organizing for Planting

Farmers can make much greater progress in tree planting if they cooperate in working out the details of the various steps required. Not only soil conservation districts but other farmer organizations may be able to purchase stock in wholesale quantities at reduced prices. Before buying, they must canvass prospective planters to find what kinds and quantities of trees are desired. Planting machines, if they can be used, will increase the volume of successful planting. In some cases, crews are organized to take the stock and plant it for busy farmers at fixed fates per thousand trees. In others, soil conservation district supervisors are able to recommend local reliable foresters or contractors who will undertake to carry all or part of the detail of planting for a fixed fee per thousand trees.